

Low Power Ambient Light and Proximity Sensor with Intelligent Interrupt and Sleep Modes - Analog and Digital Out

ISL29030

The ISL29030 is an integrated ambient and infrared light-to-digital converter with a built-in IR LED driver and I²C Interface (SMBus Compatible). This device uses two independent ADCs for concurrently measuring ambient light and proximity in parallel. The flexible interrupt scheme is designed for minimal microcontroller utilization.

For ambient light sensor (ALS) data conversions, an ADC converts photodiode current (with a light sensitivity range of 2000 Lux) in 100ms per sample. The ADC rejects 50Hz/60Hz flicker noise caused by artificial light sources. The I_{ALS} pin provides an analog output current proportional to the measured light (420µA FSR).

For proximity sensor (Prox) data conversions, the built-in driver turns on an external infrared LED and the proximity sensor ADC converts the reflected IR intensity to digital. This ADC rejects ambient IR noise (such as sunlight) and has a 540µs conversion time.

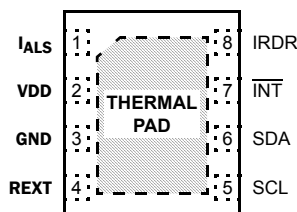
The ISL29030 provides low power operation of ALS and proximity sensing with a typical 138µA normal operation current (110µA for sensors and internal circuitry, ~28µA for external LED) with 220mA current pulses for a net 100µs, repeating every 800ms (or under).

The ISL29030 uses both a hardware pin and software bits to indicate an interrupt event has occurred. An ALS interrupt is defined as a measurement which is outside a set window. A proximity interrupt is defined as a measurement over a threshold limit. The user may also require that both ALS/prox interrupts occur at once, up to 16 times in a row before activating the interrupt pin.

The ISL29030 is designed to operate from 2.25V to 3.63V over the -40 °C to +85 °C ambient temperature range. It is packaged in a clear, lead-free 8 lead ODFN package.

Pin Configuration

ISL29030
8 LD ODFN (2.0x2.1x0.7mm)
TOP VIEW



*THERMAL PAD CAN BE CONNECTED TO GND OR ELECTRICALLY ISOLATED

Features

- Works Under All Light Sources Including Sunlight
- Dual ADCs Measure ALS/Prox Concurrently
- Intelligent Interrupt Scheme Simplifies µC Code

Ambient Light Sensing

- Simple Output Code Directly Proportional to lux
- 50Hz/60Hz Flicker Noise and IR Rejection
- Light Sensor Close to Human Eye Response
- Selectable 125/2000 Lux Range
- Analog 420µA Output Pin I_{ALS} Proportional to Lux

Proximity Sensing

- Proximity Sensor with Broad IR Spectrum
 - Can Use 850nm and 950nm External IR LEDs
- IR LED Driver with I²C Programmable Sink Currents
 - Net 100µs Pulse with 110mA or 220mA Amplitudes
 - Periodic Sleep Time up to 800ms Between Pulses
- Ambient IR Noise Cancellation (Including Sunlight)

Intelligent and Flexible Interrupts

- Independent ALS/Prox Interrupt Thresholds
- Adjustable Interrupt Persistency
 - 1/4/8/16 Consecutive Triggers Required Before Interrupt

Ultra Low Power

- 138µA DC Typical Supply Current for ALS/Prox Sensing
 - 110µA for Sensors and Internal Circuitry
 - 28µA Typical Current for External IR LED (Assuming 220mA for 100µs Every 800ms)
- <1.0µA Supply Current When Powered Down

Easy to Use

- Set Registers; Wait for Interrupt
- I²C (SMBus Compatible) Output
- Temperature Compensated
- Tiny ODFN8 2.0x2.1x0.7 (mm) Package

Additional Features

- 1.7V to 3.63V Supply for I²C Interface
- 2.25V to 3.63V Sensor Power Supply
- Pb-Free (RoHS compliant)

Applications

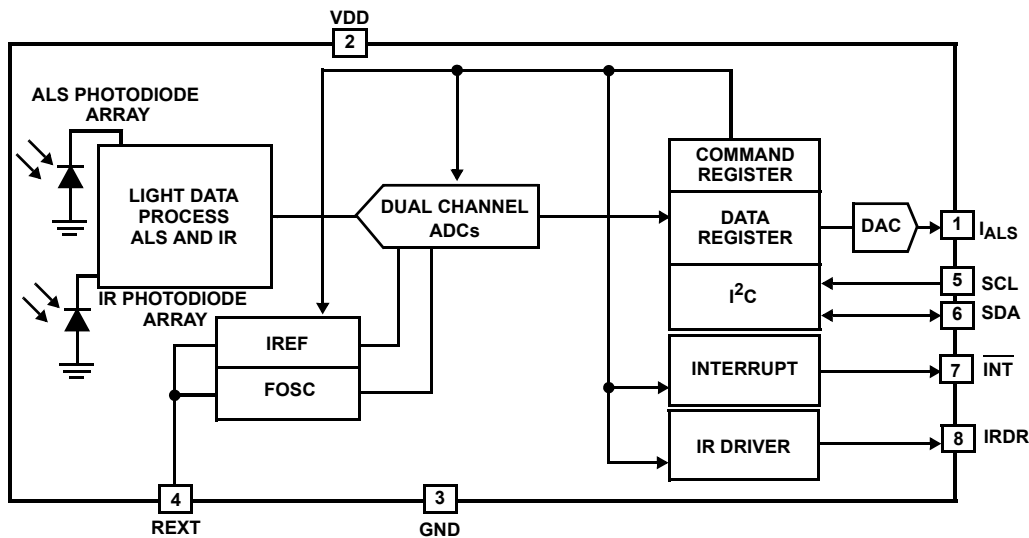
- Display and Keypad Dimming Adjustment and Proximity Sensing for:
 - Mobile Devices: Smart Phone, PDA, GPS
 - Computing Devices: Laptop PC, Netbook
 - Consumer Devices: LCD-TV, Digital Picture Frame, Digital Camera
- Industrial and Medical Light and Proximity Sensing

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Pin Descriptions

| PIN NUMBER | PIN NAME | DESCRIPTION | |
|------------|------------------|--|---|
| - | T.PAD | Thermal Pad (connect to GND or float) | |
| 1 | I _{ALS} | Analog Current Output (Proportional to ALS/IR Data Count: 420µA FSR) | |
| 2 | VDD | Positive supply: 2.25V to 3.63V | |
| 3 | GND | Ground | |
| 4 | REXT | External resistor (499kΩ; 1%) connects this pin to ground | |
| 5 | SCL | i ² C clock line | The i ² C bus lines can be pulled from 1.7V to above V _{DD} , 3.63V max |
| 6 | SDA | i ² C data line | |
| 7 | INT | Interrupt pin; Logic output (open-drain) for interrupt | |
| 8 | IRDR | IR LED driver pin - current flows into ISL29030 from LED cathode | |

Block Diagram



Ordering Information

| PART NUMBER (Notes 1, 2, 3) | TEMP. RANGE (°C) | PACKAGE TAPE AND REEL (Pb-free) | PKG. DWG. # |
|--------------------------------|---------------------|---------------------------------------|----------------|
| ISL29030IROZ-T7 | -40 to +85 | 8 Ld ODFN | L8.2.1x2.0 |
| ISL29030IROZ-EVALZ | Evaluation Board | | |

NOTES:

1. Please refer to TB347 for details on reel specifications.
2. These Intersil Pb-free plastic packaged products employ special Pb-free material sets; molding compounds/die attach materials and NiPdAu plate - e4 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.
3. For Moisture Sensitivity Level (MSL), please see device information page for [ISL29030](#). For more information on MSL please see techbrief [TB477](#).

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Absolute Maximum Ratings (T_A = +25°C)

| | |
|--|---------------------------------|
| V _{DD} Supply Voltage between V _{DD} and GND | 4.0V |
| I ² C Bus Pin Voltage (SCL, SDA) | -0.5V to 4.0V |
| I ² C Bus Pin Current (SCL, SDA) | <10mA |
| R _{EXT} Pin Voltage | -0.5V to V _{DD} + 0.5V |
| IRDR Pin Voltage | 5.5V |
| I _{ALS} Pin Voltage | -0.5V to V _{DD} + 0.5V |
| INT Pin Voltage | -0.5V to 4.0V |
| INT Pin Current | <10mA |
| ESD Rating | |
| Human Body Model (Note 5) | 2kV |

Thermal Information

| | |
|---|---------------------------|
| Thermal Resistance (Typical, Note 4) | θ _{JA} (°C/W) |
| 8 Ld ODFN | 88 |
| Maximum Die Temperature | +90°C |
| Storage Temperature | -40°C to +100°C |
| Operating Temperature | -40°C to +85°C |
| Pb-Free Reflow Profile (*) | see TB477 |
| *Peak temperature during solder reflow +235°C max | |

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

NOTES:

- θ_{JA} is measured in free air with the component mounted on a high effective thermal conductivity test board with “direct attach” features. See Tech Brief [TB379](#).
- ESD on all pins is 2kV except for IRDR, which is 1.5kV.

IMPORTANT NOTE: All parameters having Min/Max specifications are guaranteed. Typical values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: T_J = T_C = T_A

Electrical Specifications V_{DD} = 3.0V, T_A = +25°C, R_{EXT} = 499kΩ 1% tolerance.

| PARAMETER | DESCRIPTION | CONDITION | MIN (Note 10) | TYP | MAX (Note 10) | UNIT |
|-------------------------|---|--|---------------|------|----------------------|--------|
| V _{DD} | Power Supply Range | | 2.25 | 3.0 | 3.63 | V |
| SR_V _{DD} | Input Power-up Slew Rate | V _{DD} Rising Edge between 0.4V and 2.25V | 0.5 | | | V/ms |
| I _{DD_OFF} | Supply Current when Powered Down | ALS_EN = 0; PROX_EN = 0 | | 0.1 | 0.8 | μA |
| I _{DD_NORM} | Supply Current for ALS+Prox in Sleep Time | ALS_EN = 1; PROX_EN = 1 | | 116 | 135 | μA |
| I _{DD_PRX_SLP} | Supply Current for Prox in Sleep Time | ALS_EN = 0; PROX_EN = 1 | | 85 | | μA |
| I _{DD_ALS} | Supply Current for ALS | ALS_EN = 1; PROX_EN = 0 | | 102 | | μA |
| f _{OSC} | Internal Oscillator Frequency | | | 5.25 | | MHz |
| t _{INTGR_ALS} | 12-bit ALS Integration/Conversion Time | | 88 | 100 | 112 | ms |
| t _{INTGR_PROX} | 8-bit Prox Integration/Conversion Time | | | 0.54 | | ms |
| I _{ALS_OFF} | I _{ALS} Output Current when ALS = Disabled | ALS_EN = 0; V _{I_ALS} = 0V | | 3 | 100 | nA |
| I _{ALS_0} | I _{ALS} Output Current When Dark | ALS_EN = 1; ALS_RANGE = 1; E = 0 Lux | | 0.1 | 0.6 | μA |
| I _{ALS_1} | Current Output under Specified Conditions | E = 53 lux, Fluorescent (Note 6), ALS_RANGE = 0 | | 161 | | μA |
| I _{ALS_2} | Current Output under Specified Conditions | E = 320 lux, Fluorescent (Note 6) ALS_RANGE = 1 | 40 | 60 | 80 | μA |
| I _{ALS_F} | I _{ALS} Output Current At Full Scale | ALS_EN = 1; ALS Code = 4095 | 380 | 420 | 460 | μA |
| V _{I_ALS} | Compliance Voltage on I _{ALS} w/ 5% Variation in Output Current | ALS_EN = 1; ALS Code = 4095 | 0 | | V _{DD} -0.8 | V |
| DATA _{ALS_0} | ALS Result when Dark | E _{AMBIENT} = 0 lux, 2k Range | | 1 | 3 | Counts |
| DATA _{ALS_F} | Full Scale ALS ADC Code | E _{AMBIENT} > Selected Range Maximum Lux (Note 9) | | | 4095 | Counts |
| ΔDATA _{DATA} | Count Output Variation Over Three Light Sources: Fluorescent, Incandescent and Sunlight | Ambient Light Sensing | | ±10 | | % |
| DATA _{ALS_1} | Light Count Output with LSB of 0.0326 lux/count | E = 53 lux, Fluorescent (Notes 6, 9), ALS_RANGE = 0 | | 1638 | | Counts |

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Electrical Specifications $V_{DD} = 3.0V$, $T_A = +25^\circ C$, $R_{EXT} = 499k\Omega$ 1% tolerance. (Continued)

| PARAMETER | DESCRIPTION | CONDITION | MIN (Note 10) | TYP | MAX (Note 10) | UNIT |
|------------------------|---|--|---------------|-------|---------------|---------|
| DATA _{ALS_2} | Light Count Output With LSB of 0.522 lux/count | E = 320 lux, Fluorescent (Note 6) ALS_RANGE = 1 | 460 | 614 | 768 | Counts |
| DATA _{PROX_0} | Prox Measurement w/o Object in Path | | | 1 | 2 | Counts |
| DATA _{PROX_F} | Full Scale Prox ADC Code | | | | 255 | Counts |
| DATA _{PROX_1} | Prox Measurement Result | (Note 7) | 35 | 46 | 57 | Counts |
| t_r | Rise Time for IRDR Sink Current | $R_{LOAD} = 15\Omega$ at IRDR pin, 20% to 80% | | 500 | | ns |
| t_f | Fall time for IRDR Sink Current | $R_{LOAD} = 15\Omega$ at IRDR pin, 80% to 20% | | 500 | | ns |
| I_{IRDR_0} | IRDR Sink Current | PROX_DR = 0; $V_{IRDR} = 0.5V$ | 98 | 110 | 120 | mA |
| I_{IRDR_1} | IRDR Sink Current | PROX_DR = 1; $V_{IRDR} = 0.5V$ | | 220 | | mA |
| I_{IRDR_LEAK} | IRDR Leakage Current | PROX_EN = 0; $V_{DD} = 3.63V$ (Note 8) | -1 | 0.001 | 1 | μA |
| V_{IRDR} | Acceptable Voltage Range on IRDR Pin | Register bit PROX_DR = 0 | 0.5 | | 4.3 | V |
| t_{PULSE} | Net I_{IRDR} On Time Per PROX Reading | | | 100 | | μs |
| V_{REF} | Voltage of R_{EXT} Pin | | | 0.51 | | V |
| F_{I^2C} | I ² C Clock Rate Range | | | | 400 | kHz |
| V_{I^2C} | Supply Voltage Range for I ² C Interface | | 1.7 | | 3.63 | V |
| V_{IL} | SCL and SDA Input Low Voltage | | | | 0.55 | V |
| V_{IH} | SCL and SDA Input High Voltage | | 1.25 | | | V |
| I_{SDA} | SDA Current Sinking Capability | $V_{OL} = 0.4V$ | 3 | 5 | | mA |
| I_{INT} | \overline{INT} Current Sinking Capability | $V_{OL} = 0.4V$ | 3 | 5 | | mA |
| PSRR _{IRDR} | $(\Delta I_{IRDR})/(\Delta V_{IRDR})$ | PROX_DR = 0; $V_{IRDR} = 0.5V$ to 4.3V | | 4 | | mA/V |

NOTES:

- An LED is used in production test. The LED irradiance is calibrated to produce the same DATA count against a fluorescent light source of the same lux level.
- An 850nm infrared LED is used to test PROX/IR sensitivity in an internal test mode.
- Ability to guarantee I_{IRDR} leakage of $\sim 1nA$ is limited by test hardware.
- For ALS applications under light-distorting glass, please see the section titled "ALS Range 1 Considerations" on page 11.
- Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.

I²C Electrical Specifications For SCL and SDA unless otherwise noted, $V_{DD} = 3V$, $T_A = +25^\circ C$, $R_{EXT} = 499k\Omega$ 1% tolerance (Note 11).

| PARAMETER | DESCRIPTION | CONDITION | MIN | TYP | MAX | UNIT |
|------------|---|-----------|---------------|-----|------|---------|
| V_{I^2C} | Supply Voltage Range for I ² C Interface | | 1.7 | | 3.63 | V |
| f_{SCL} | SCL Clock Frequency | | | | 400 | kHz |
| V_{IL} | SCL and SDA Input Low Voltage | | | | 0.55 | V |
| V_{IH} | SCL and SDA Input High Voltage | | 1.25 | | | V |
| V_{hys} | Hysteresis of Schmitt Trigger Input | | 0.05 V_{DD} | | | V |
| V_{OL} | Low-level Output Voltage (Open-drain) at 4mA Sink Current | | | | 0.4 | V |
| I_i | Input Leakage for each SDA, SCL Pin | | -10 | | 10 | μA |
| t_{SP} | Pulse Width of Spikes that must be Suppressed by the Input Filter | | | | 50 | ns |
| t_{AA} | SCL Falling Edge to SDA Output Data Valid | | | | 900 | ns |

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I²C Electrical Specifications For SCL and SDA unless otherwise noted, V_{DD} = 3V, T_A = +25°C, R_{EXT} = 499kΩ 1% tolerance (Note 11). (Continued)

| PARAMETER | DESCRIPTION | CONDITION | MIN | TYP | MAX | UNIT |
|----------------------|--|--|-------------------------|-----|-----|------|
| C _i | Capacitance for each SDA and SCL Pin | | | | 10 | pF |
| t _{HD:STA} | Hold Time (Repeated) START Condition | After this period, the first clock pulse is generated | 600 | | | ns |
| t _{LOW} | LOW Period of the SCL Clock | Measured at the 30% of VDD crossing | 1300 | | | ns |
| t _{HIGH} | HIGH period of the SCL Clock | | 600 | | | ns |
| t _{SU:STA} | Set-up Time for a Repeated START Condition | | 600 | | | ns |
| t _{HD:DAT} | Data Hold Time | | 30 | | | ns |
| t _{SU:DAT} | Data Set-up Time | | 100 | | | ns |
| t _R | Rise Time of both SDA and SCL Signals | (Note 12) | 20 + 0.1xC _b | | | ns |
| t _F | Fall Time of both SDA and SCL Signals | (Note 12) | 20 + 0.1xC _b | | | ns |
| t _{SU:STO} | Set-up Time for STOP Condition | | 600 | | | ns |
| t _{BUF} | Bus Free Time Between a STOP and START Condition | | 1300 | | | ns |
| C _b | Capacitive Load for Each Bus Line | | | | 400 | pF |
| R _{pull-up} | SDA and SCL system bus pull-up resistor | Maximum is determined by t _R and t _F | 1 | | | kΩ |
| t _{VD:DAT} | Data Valid Time | | | | 0.9 | μs |
| t _{VD:ACK} | Data Valid Acknowledge Time | | | | 0.9 | μs |
| V _{nL} | Noise Margin at the LOW Level | | 0.1VDD | | | V |
| V _{nH} | Noise Margin at the HIGH Level | | 0.2VDD | | | V |

NOTES:

11. I²C limits are based on design/simulation and are not production tested.
12. C_b is the capacitance of the bus in pF.

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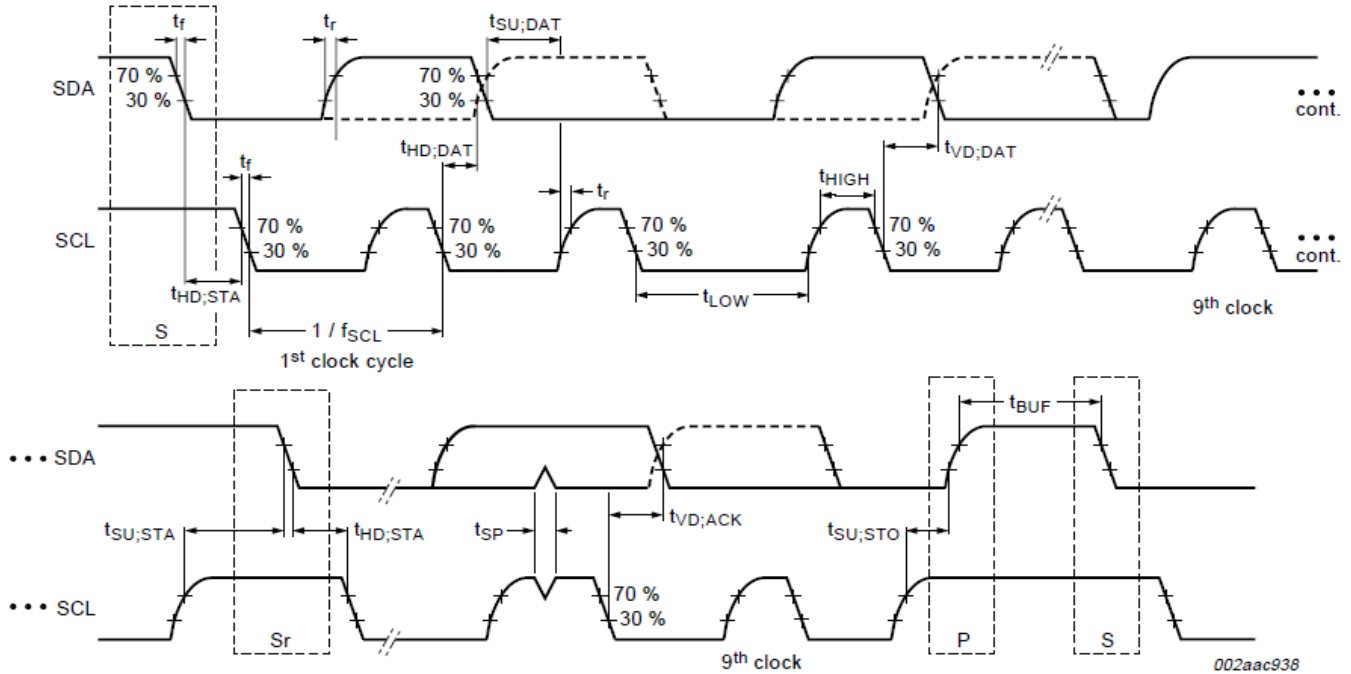


FIGURE 1. I²C TIMING DIAGRAM

Register Map

There are ten 8-bit registers accessible via I²C. Registers 0x1 and 0x2 define the operation mode of the device. Registers 0x3 through 0x7 store the various ALS/IR/Prox thresholds which trigger interrupt events. Registers 0x8 through 0xA store the results of ALS/IR/Prox ADC conversions.

TABLE 1. ISL29030 REGISTERS AND REGISTER BITS

| ADDR | REG NAME | BIT | | | | | | | | DEFAULT |
|------|-----------|------------------------|----------------|---|------------------|------------------|---------------|-----------|------------|---------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| 0x00 | (n/a) | <i>(Reserved)</i> | | | | | | | | (n/a) |
| 0x01 | CONFIGURE | PROX_EN | PROX_SLP[2:0] | | | PROX_DR | ALS_EN | ALS_RANGE | ALSIR_MODE | 0x00 |
| 0x02 | INTERRUPT | PROX_FLAG | PROX_PRST[1:0] | | <i>(Write 0)</i> | ALS_FLAG | ALS_PRST[1:0] | | INT_CTRL | 0x00 |
| 0x03 | PROX_LT | PROX_LT[7:0] | | | | | | | | 0x00 |
| 0x04 | PROX_HT | PROX_HT[7:0] | | | | | | | | 0xFF |
| 0x05 | ALSIR_TH1 | ALSIR_LT[7:0] | | | | | | | | 0x00 |
| 0x06 | ALSIR_TH2 | ALSIR_HT[3:0] | | | | ALSIR_LT[11:8] | | | | 0xF0 |
| 0x07 | ALSIR_TH3 | ALSIR_HT[11:4] | | | | | | | | 0xFF |
| 0x08 | PROX_DATA | PROX_DATA[7:0] | | | | | | | | 0x00 |
| 0x09 | ALSIR_DT1 | ALSIR_DATA[7:0] | | | | | | | | 0x00 |
| 0x0A | ALSIR_DT2 | <i>(Unused)</i> | | | | ALSIR_DATA[11:8] | | | | 0x00 |
| 0x0E | TEST1 | <i>(Write as 0x00)</i> | | | | | | | | 0x00 |
| 0x0F | TEST2 | <i>(Write as 0x00)</i> | | | | | | | | 0x00 |

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Register Descriptions

TABLE 2. REGISTER 0x00 (RESERVED)

| BIT # | ACCESS | DEFAULT | NAME | FUNCTION/OPERATION |
|-------|--------|---------|-------|-------------------------------------|
| 7:0 | RO | (n/a) | (n/a) | Reserved - no need to read or write |

TABLE 3. REGISTER 0x01 (CONFIGURE) - PROX/ALS CONFIGURATION

| BIT # | ACCESS | DEFAULT | NAME | FUNCTION/OPERATION |
|-------|--------|---------|----------------------------|--|
| 7 | RW | 0x00 | PROX_EN (Prox Enable) | When = 0, proximity sensing is disabled When = 1, continuous proximity sensing is enabled. Prox data will be ready 0.54ms after this bit is set high |
| 6:4 | RW | 0x00 | PROX_SLP (Prox Sleep) | For bits 6:4 = (see the following) 111; sleep time between prox IR LED pulses is 0.0ms (run continuously) 110; sleep time between prox IR LED pulses is 12.5ms 101; sleep time between prox IR LED pulses is 50ms 100; sleep time between prox IR LED pulses is 75ms 011; sleep time between prox IR LED pulses is 100ms 010; sleep time between prox IR LED pulses is 200ms 001; sleep time between prox IR LED pulses is 400ms 000; sleep time between prox IR LED pulses is 800ms |
| 3 | RW | 0x00 | PROX_DR (Prox Drive) | When = 0, IRDR behaves as a pulsed 110mA current sink When = 1, IRDR behaves as a pulsed 220mA current sink |
| 2 | RW | 0x00 | ALS_EN (ALS Enable) | When = 0, ALS/IR sensing is disabled When = 1, continuous ALS/IR sensing is enabled with new data ready every 100ms |
| 1 | RW | 0x00 | ALS_RANGE (ALS Range) | When = 0, ALS is in low-lux range When = 1, ALS is in high-lux range |
| 0 | RW | 0x00 | ALSIR_MODE (ALSIR Mode) | When = 0, ALS/IR data register contains visible ALS sensing data When = 1, ALS/IR data register contains IR spectrum sensing data |

TABLE 4. REGISTER 0x02 (INTERRUPT) - PROX/ALS INTERRUPT CONTROL

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|---------------------------------|---|
| 7 | FLAG | 0x00 | PROX_FLAG (Prox Flag) | When = 0, no Prox interrupt event has occurred since power-on or last "clear" When = 1, a Prox interrupt event occurred. Clearable by writing "0" |
| 6:5 | RW | 0x00 | PROX_PRST (Prox Persist) | For bits 6:5 = (see the following) 00; set PROX_FLAG if 1 conversion result trips the threshold value 01; set PROX_FLAG if 4 conversion results trip the threshold value 10; set PROX_FLAG if 8 conversion results trip the threshold value 11; set PROX_FLAG if 16 conversion results trip the threshold value |
| 4 | RW | 0x00 | <i>Unused</i> (Write 0) | Unused register bit - write 0 |
| 3 | FLAG | 0x00 | ALS_FLAG (ALS FLAG) | When = 0, no ALS interrupt event has occurred since power-on or last "clear" When = 1, an ALS interrupt event occurred. Clearable by writing "0" |
| 2:1 | RW | 0x00 | ALS_PRST (ALS Persist) | For bits 2:1 = (see the following) 00; set ALS_FLAG if 1 conversion is outside the set window 01; set ALS_FLAG if 4 conversions are outside the set window 10; set ALS_FLAG if 8 conversions are outside the set window 11; set ALS_FLAG if 16 conversions are outside the set window |
| 0 | RW | 0x00 | INT_CTRL (Interrupt Control) | When = 0, set $\overline{\text{INT}}$ pin low if PROX_FLAG or ALS_FLAG high (logical OR) When = 1, set $\overline{\text{INT}}$ pin low if PROX_FLAG and ALS_FLAG high (logical AND) |

TABLE 5. REGISTER 0x03 (PROX_LT) - INTERRUPT LOW THRESHOLD FOR PROXIMITY SENSOR

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|-----------------------------|---|
| 7:0 | RW | 0x00 | PROX_LT (Prox Threshold) | 8-bit interrupt low threshold for proximity sensing |

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TABLE 6. REGISTER 0x04 (PROX_HT) - INTERRUPT HIGH THRESHOLD FOR PROXIMITY SENSOR

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|-----------------------------|--|
| 7:0 | RW | 0xFF | PROX_HT (Prox Threshold) | 8-bit interrupt high threshold for proximity sensing |

TABLE 7. REGISTER 0x05 (ALSIR_TH1) - INTERRUPT LOW THRESHOLD FOR ALS/IR

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|------------------------------------|--|
| 7:0 | RW | 0x00 | ALSIR_LT[7:0] (ALS/IR Low Thr.) | Lower 8 bits (of 12 bits) for ALS/IR low interrupt threshold |

TABLE 8. REGISTER 0x06 (ALSIR_TH2) - INTERRUPT LOW/HIGH THRESHOLDS FOR ALS/IR

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|-------------------------------------|---|
| 7:4 | RW | 0x0F | ALSIR_HT[3:0] (ALS/IR High Thr.) | Lower 4 bits (of 12 bits) for ALS/IR high interrupt threshold |
| 3:0 | RW | 0x00 | ALSIR_LT[11:8] (ALS/IR Low Thr.) | Upper 4 bits (of 12 bits) for ALS/IR low interrupt threshold |

TABLE 9. REGISTER 0x07 (ALSIR_TH3) - INTERRUPT HIGH THRESHOLD FOR ALS/IR

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|--------------------------------------|---|
| 7:0 | RW | 0xFF | ALSIR_HT[11:4] (ALS/IR High Thr.) | Upper 8 bits (of 12 bits) for ALS/IR high interrupt threshold |

TABLE 10. REGISTER 0x08 (PROX_DATA) - PROXIMITY SENSOR DATA

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|-------------------------------|--|
| 7:0 | RO | 0x00 | PROX_DATA (Proximity Data) | Results of 8-bit proximity sensor ADC conversion |

TABLE 11. REGISTER 0x09 (ALSIR_DT1) - ALS/IR SENSOR DATA (LOWER 8 BITS)

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|-----------------------------|---|
| 7:0 | RO | 0x00 | ALSIR_DATA (ALS/IR Data) | Lower 8 bits (of 12 bits) from result of ALS/IR sensor conversion |

TABLE 12. REGISTER 0x0A (ALSIR_DT2) - ALS/IR SENSOR DATA (UPPER 4 BITS)

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|-----------------------------|---|
| 7:4 | RO | 0x00 | (Unused) | Unused bits. |
| 3:0 | RO | 0x00 | ALSIR_DATA (ALS/IR Data) | Upper 4 bits (of 12 bits) from result of ALS/IR sensor conversion |

TABLE 13. REGISTER 0x0E (TEST1) - TEST MODE

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|-----------------|---|
| 7:0 | RW | 0x00 | (Write as 0x00) | Test mode register. When 0x00, in normal operation. |

TABLE 14. REGISTER 0x0F (TEST2) - TEST MODE 2

| BIT # | ACCESS | DEFAULT | BIT NAME | FUNCTION/OPERATION |
|-------|--------|---------|-----------------|---|
| 7:0 | RW | 0x00 | (Write as 0x00) | Test mode register. When 0x00, in normal operation. |

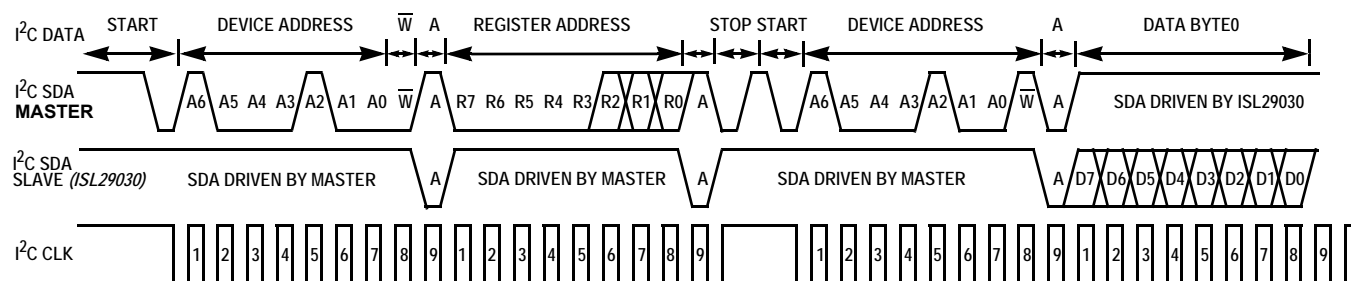


FIGURE 2. I²C DRIVER TIMING DIAGRAM FOR MASTER AND SLAVE CONNECTED TO COMMON BUS

Principles of Operation

I²C Interface

The ISL29030's I²C interface slave address is internally hardwired as 0b1000100.

Figure 2 shows a sample one-byte read. The I²C bus master always drives the SCL (clock) line, while either the master or the slave can drive the SDA (data) line. Every I²C transaction begins with the master asserting a start condition (SDA falling while SCL remains high). The first transmitted byte is initiated by the master and includes 7 address bits and a R/W bit. The slave is responsible for pulling SDA low during the ACK bit after every transmitted byte.

Each I²C transaction ends with the master asserting a stop condition (SDA rising while SCL remains high).

For more information about the I²C standard, please consult the Philips™ I²C specification documents.

Photodiodes and ADCs

The ISL29030 contains two photodiode arrays which convert photons (light) into current. The ALS photodiodes are constructed to mimic the human eye's wavelength response curve to visible light (see Figure 7). The ALS photodiodes' current output is digitized by a 12-bit ADC in 100ms. These 12 bits can be accessed by reading from I²C registers 0x9 and 0xA when the ADC conversion is completed.

The ALS converter is a charge-balancing integrating 12-bit ADC. Charge-balancing is best for converting small current signals in the presence of periodic AC noise. Integrating over 100ms highly rejects both 50Hz and 60Hz light flicker by picking the lowest integer number of cycles for both 50Hz/60Hz frequencies.

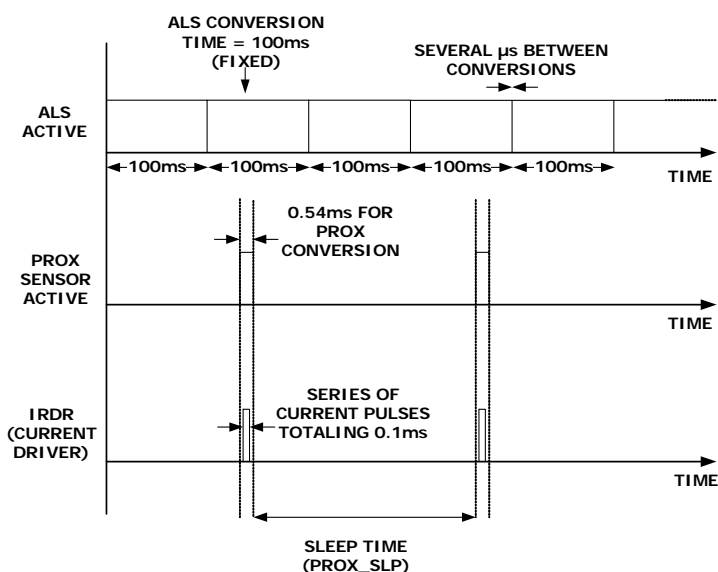


FIGURE 3. TIMING DIAGRAM FOR PROX/ALS EVENTS - NOT TO SCALE

The proximity sensor is an 8-bit ADC which operates in a similar fashion. When proximity sensing is enabled, the IRDR pin will drive a user-supplied infrared LED, the emitted IR reflects off an object (i.e., a human head) back into the ISL29030, and a sensor converts the reflected IR wave to a current signal in 0.54ms. The ADC subtracts the IR reading before and after the LED is driven (to remove ambient IR such as sunlight), and converts this value to a digital count stored in Register 0x8.

The ISL29030 is designed to run two conversions concurrently: a proximity conversion and an ALS (or IR) conversion. Please note that because of the conversion times, the user must let the ADCs perform one full conversion first before reading from I²C Registers PROX_DATA (wait 0.54ms) or ALSIR_DT1/2 (wait 100ms). The timing between ALS and Prox conversions is arbitrary (as shown in Figure 3). The ALS runs continuously with new data available every 100ms. The proximity sensor runs continuously with a time between conversions decided by PROX_SLP (Register 1 Bits [6:4]).

Ambient Light and IR Sensing

The ISL29030 is set for ambient light sensing when Register bit ALSIR_MODE = 0 and ALR_EN = 1. The light-wavelength response of the ALS appears as shown in Figure 6. ALS measuring mode (as opposed to IR measuring mode) is set by default.

When the part is programmed for infrared (IR) sensing (ALSIR_MODE = 1; ALS_EN = 1), infrared light is converted into a current and digitized by the same ALS ADC. The result of an IR conversion is *strongly related* to the amount of IR energy incident on our sensor, but is unitless and is referred to in digital counts.

Proximity Sensing

When proximity sensing is enabled (PROX_EN = 1), the external IR LED is driven for 0.1ms by the built-in IR LED driver through the IRDR pin. The amplitude of the IR LED current depends on Register 1 bit 3: PROX_DR. If this bit is low, the load will see a fixed 110mA current pulse. If this bit is high, the load on IRDR

will see a fixed 220mA current pulse as seen in Figure 4.

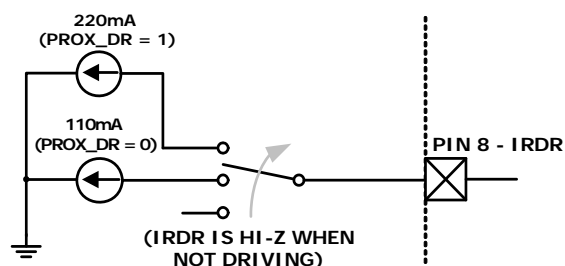


FIGURE 4. CURRENT DRIVE MODE OPTIONS

When the IR from the LED reaches an object and gets reflected back into the ISL29030, the reflected IR light is converted into current as per the IR spectral response shown in Figure 7. One entire proximity measurement takes 0.54ms for one conversion (which includes 0.1ms spent driving the LED), and the period between proximity measurements is decided by PROX_SLP (sleep time) in Register 1 Bits 6:4.

Average LED driving current consumption is given by Equation 1.

$$I_{\text{IRDR:AVE}} = \frac{I_{\text{IRDR:PEAK}} \times 100\mu\text{s}}{T_{\text{SLEEP}}} \quad (\text{EQ. 1})$$

A typical IRDR scheme is 220mA amplitude pulses every 800ms, which yields 28μA DC.

Total Current Consumption

Total current consumption is the sum of I_{DD} and I_{IRDR}. The IRDR pin sinks current (as shown in Figure 4) and the average IRDR current can be calculated using Equation 1. I_{DD} depends on voltage and the mode-of-operation as seen in Figure 11.

Interrupt Function

The ISL29030 has an intelligent interrupt scheme designed to shift some logic processing away from intensive microcontroller I²C polling routines (which consume power) and towards a more

independent light sensor which can instruct a system to “wake up” or “go to sleep.”

An ALS interrupt event (ALS_FLAG) is governed by Registers 5 through 7. The user writes a high and low threshold value to these registers and the ISL29030 will issue an ALS interrupt flag if the actual count stored in Registers 0x9 and 0xA are outside the user’s programmed window. The user must write 0 to clear the ALS_FLAG.

A proximity interrupt event (PROX_FLAG) is governed by the high and low thresholds in registers 3 and 4 (PROX_LT and PROX_HT). PROX_FLAG is set when the measured proximity data is more than the higher threshold X-times-in-a-row (X is set by user; see following paragraph). The proximity interrupt flag is cleared when the prox data is lower than the low proximity threshold X-times-in-a-row, or when the user writes “0” to PROX_FLAG.

Interrupt persistency is another useful option available for both ALS and proximity measurements. Persistency requires X-in-a-row interrupt flags before the INT pin is driven low. Both ALS and Prox have their own independent interrupt persistency options. See ALS_PRST and PROX_PRST bits in Register 2.

The final interrupt option is the ability to AND or OR the two interrupt flags using Register 2 Bit 0 (INT_CTRL). If the user wants both ALS/Prox interrupts to happen at the same time before changing the state of the interrupt pin, set this bit high. If the user wants the interrupt pin to change state when *either* the ALS or the Proximity interrupt flag goes high, leave this bit to its default of 0.

Analog-Out I_{ALS} Pin

When ALS_EN = 1, The analog I_{ALS} output pin sources a current directly proportional to the digital count stored in register bits ALSIRDATA[11:0]. When ALS_EN = 0, this pin is in a high impedance state. See Figure 15 for the effects of the compliance voltage V_{I_ALS} on I_{ALS}.

ALS Range 1 Considerations

When measuring ALS counts higher than 1800 on range 1 (ALSIR_MODE = 0, ALS_RANGE = 0, ALS_DATA > 1800), switch to range 2 (change the ALS_RANGE bit from “0” to “1”) and remeasure ALS counts. This recommendation pertains only to applications where the light incident upon the sensor is IR-heavy and is distorted by tinted glass that *increases* the ratio of infrared to visible light. For more information, see the separate *ALS Range 1 Considerations* document.

V_{DD} Power-up and Power Supply Considerations

Upon power-up, please ensure a V_{DD} slew rate of 0.5V/ms or greater. After power-up, or if the user’s power supply temporarily deviates from our specification (2.25V to 3.63V), Intersil recommends the user write the following: write 0x00 to register 0x01, write 0x29 to register 0x0F, write 0x00 to register 0x0E, and write 0x00 to register 0x0F. The user should then wait ~1ms or more and then rewrite all registers to the desired values. If the user prefers a hardware reset method instead of writing to test registers: set V_{DD} = 0V for 1 second or more, power back up at the required slew rate, and write registers to the desired values.

Power-Down

The power-down can be set 2 ways by the user. The first is to set both PROX_EN and ALS_EN bits to 0 in Register 1. The second and more simple way is to set all bits in Register 1 to 0 (0x00).

Calculating Lux

The ISL29030’s ADC output codes are directly proportional to lux when in ALS mode (see ALSIR_MODE bit).

$$E_{calc} = \alpha_{RANGE} \times OUT_{ADC} \quad (EQ. 2)$$

In Equation 2, E_{calc} is the calculated lux reading and OUT represents the ADC code. The constant α to plug in is determined by the range bit ALS_RANGE (register 0x1 bit 1) and is independent of the light source type.

TABLE 15. ALS SENSITIVITY AT DIFFERENT RANGES

| ALS_RANGE | α_{RANGE} (Lux/Count) |
|-----------|---------------------------------|
| 0 | 0.0326 |
| 1 | 0.522 |

Table 15 shows two different scale factors: one for the low range (ALS_RANGE = 0) and the other for the high range (ALS_RANGE = 1).

Noise Rejection

Charge balancing ADC’s have excellent noise-rejection characteristics for periodic noise sources whose frequency is an integer multiple of the conversion rate. For instance, a 60Hz AC unwanted signal’s sum from 0ms to $k \cdot 16.66ms$ ($k = 1, 2, \dots, k_j$) is zero. Similarly, setting the device’s integration time to be an integer multiple of the periodic noise signal greatly improves the light sensor output signal in the presence of noise. Since wall sockets may output at 60Hz or 50Hz, our integration time is 100ms: the lowest common integer number of cycles for both frequencies.

Proximity Detection of Various Objects

Proximity sensing relies on the amount of IR reflected back from objects. A perfectly black object would absorb all light and reflect no photons. The ISL29030 is sensitive enough to detect black ESD foam which reflects only 1% of IR. For biological objects, blonde hair reflects more than brown hair and customers may notice that skin tissue is much more reflective than hair. IR penetrates into the skin and is reflected or scattered back from within. As a result, the proximity count peaks at contact and monotonically decreases as skin moves away. The reflective characteristics of skin are very different from that of paper.

Typical Circuit

A typical application for the ISL29030 is shown in Figure 5. The ISL29030’s I²C address is internally hardwired as 0b1000100. The device can be tied onto a system’s I²C bus together with other I²C compliant devices.

Soldering Considerations

Convection heating is recommended for reflow soldering; direct-infrared heating is not recommended. The plastic ODFN package does not require a custom reflow soldering profile, and is qualified to +260 °C. A standard reflow soldering profile with a +260 °C maximum is recommended.

<http://www.intersil.com/data/tb/TB477.pdf>

Suggested PCB Footprint

It is important that users check the “Surface Mount Assembly Guidelines for Optical Dual FlatPack No Lead (ODFN) Package” before starting ODFN product board mounting.

<http://www.intersil.com/data/tb/TB477.pdf>

Layout Considerations

The ISL29030 is relatively insensitive to layout. Like other I²C devices, it is intended to provide excellent performance even in significantly noisy environments. There are only a few considerations that will ensure best performance.

Route the supply and I²C traces as far as possible from all sources of noise. A 0.1µF and 1µF power supply decoupling capacitors need to be placed close to the device.

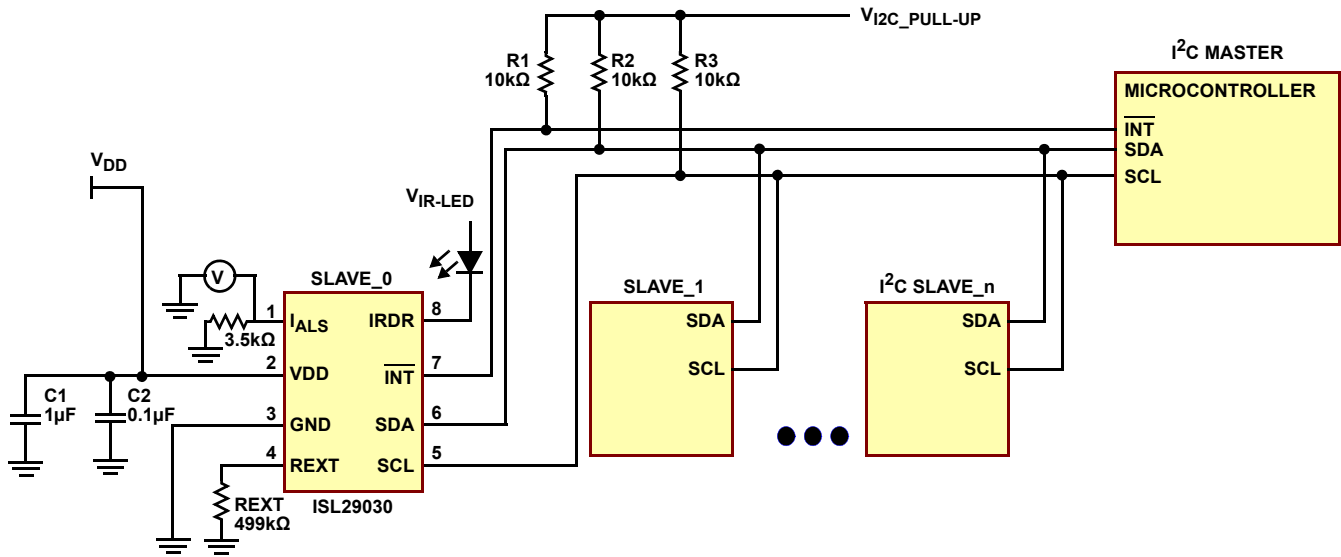


FIGURE 5. ISL29030 TYPICAL CIRCUIT

Typical Performance Curves $V_{DD} = 3.0V$, $R_{EXT} = 499k\Omega$

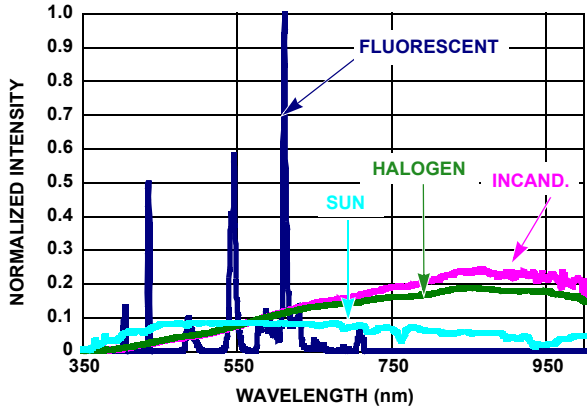


FIGURE 6. SPECTRUM OF FOUR LIGHT SOURCES NORMALIZED BY LUMINOUS INTENSITY (LUX)

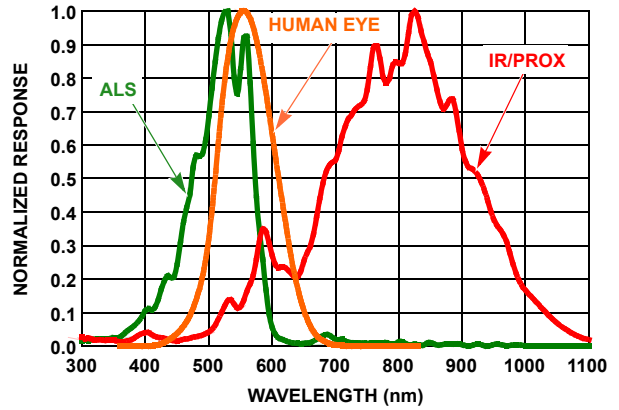


FIGURE 7. ISL29030 SENSITIVITY TO DIFFERENT WAVELENGTHS

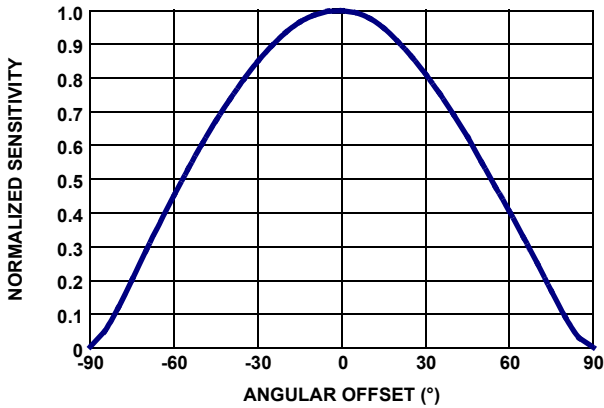


FIGURE 8. ANGULAR SENSITIVITY

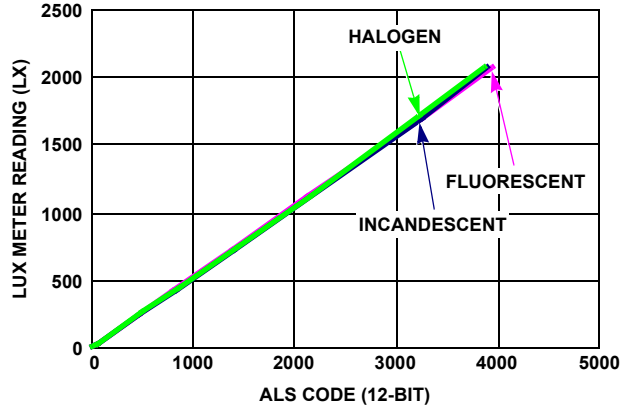


FIGURE 9. ALS LINEARITY OVER 3 LIGHT SOURCES (2000 LUX RANGE)

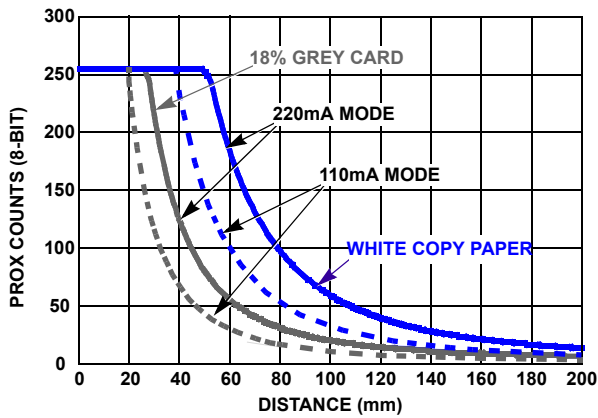


FIGURE 10. PROX COUNTS vs DISTANCE WITH 10CM x 10CM REFLECTOR (USING ISL29030 EVALUATION BOARD)

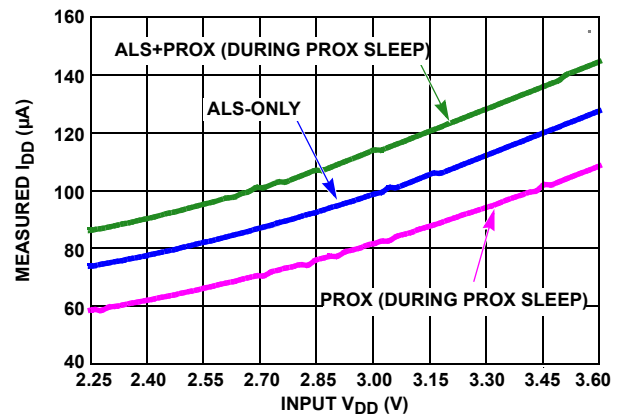


FIGURE 11. V_{DD} vs I_{DD} FOR VARIOUS MODES OF OPERATION (I_{ALS} PIN FLOATING)

Typical Performance Curves $V_{DD} = 3.0V$, $R_{EXT} = 499k\Omega$ (Continued)

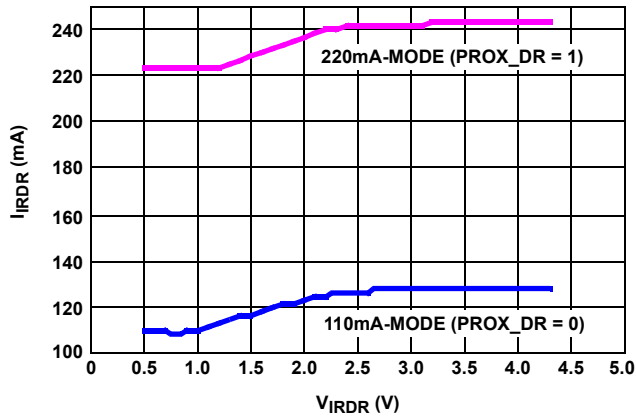


FIGURE 12. IRDR PULSE AMPLITUDE vs V_{IRDR}

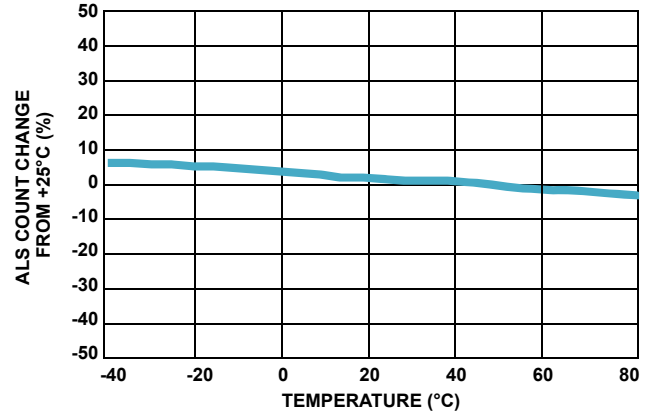


FIGURE 13. STABILITY OF ALS COUNT OVER-TEMPERATURE (AT 300 LUX)

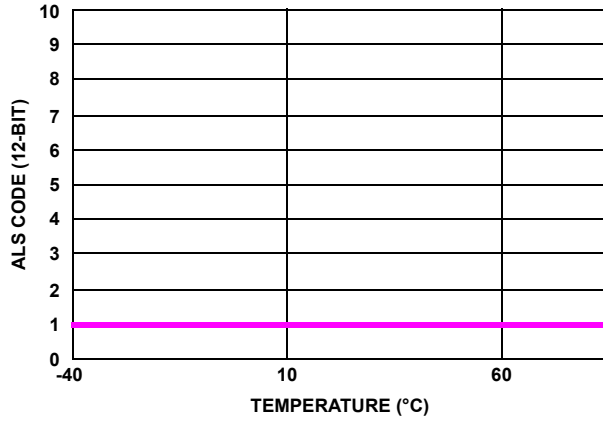


FIGURE 14. STABILITY OF ALS COUNT OVER-TEMPERATURE (AT 0.00 LUX)

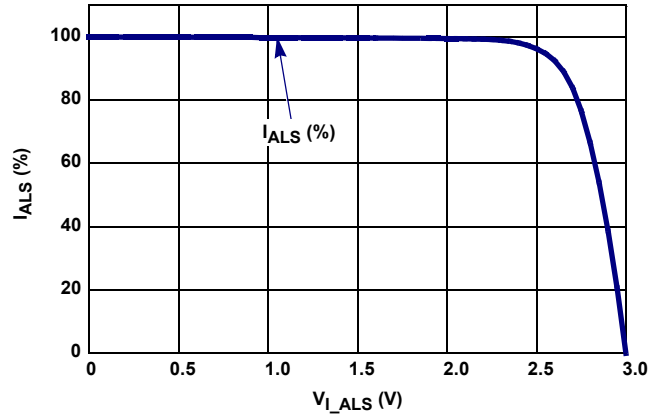


FIGURE 15. COMPLIANCE VOLTAGE V_{I_ALS} 'S EFFECTS ON I_{ALS} (REFERENCED TO $V_{I_ALS} = 0V$)

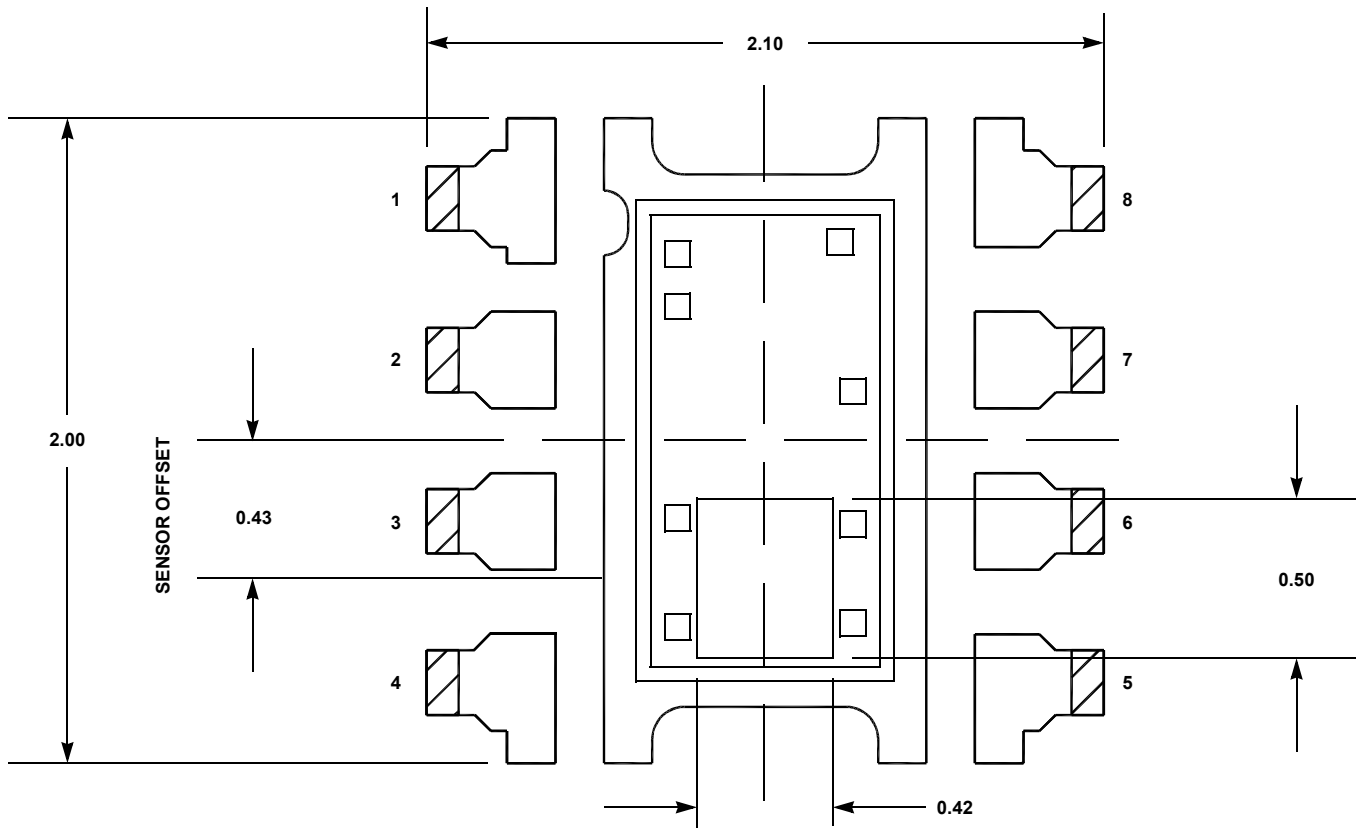


FIGURE 16. 8 LD ODFN SENSOR LOCATION OUTLINE - DIMENSIONS IN mm

Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest Rev.

| DATE | REVISION | CHANGE |
|----------|----------|---|
| 4/19/11 | FN6872.1 | Corrected Tech Brief reference in Note 3 of "Ordering Information" on page 2 from TB363 to TB477. Added Note 10 to MIN MAX columns of "Electrical Specifications" on page 3. Updated "Package Outline Drawing" on page 17 as follows: -In the "bottom view" image, added a dimension from the edge of the package to the edge of the first lead, which is 0.15mm. Also added a dimension from the edge of the package (top edge in the picture) to the center of the lead, which is 0.25mm -Changed the drawing in the bottom view to show the new look of the pin#1 indicator -Corrected note 4 from "Dimension b applies.." to "Dimension applies..." -Added note 4 callout to bottom view -Enclosed Note #'s 4, 5, 6 in triangles |
| 10/18/10 | | Updates to test methodology, addition of "ALS Range 1 Considerations" paragraph, updates to "Power-Up" Sequence, test register clarification, I_als FSR typo fixes |
| 6/15/10 | FN6872.0 | Initial release. |

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For a complete listing of Applications, Related Documentation and Related Parts, please see the respective product information page. Also, please check the product information page to ensure that you have the most updated datasheet: [ISL29030](http://www.intersil.com)

To report errors or suggestions for this datasheet, please go to: www.intersil.com/askourstaff

Reliability reports are available from our website at: <http://rel.intersil.com/reports/search.php>

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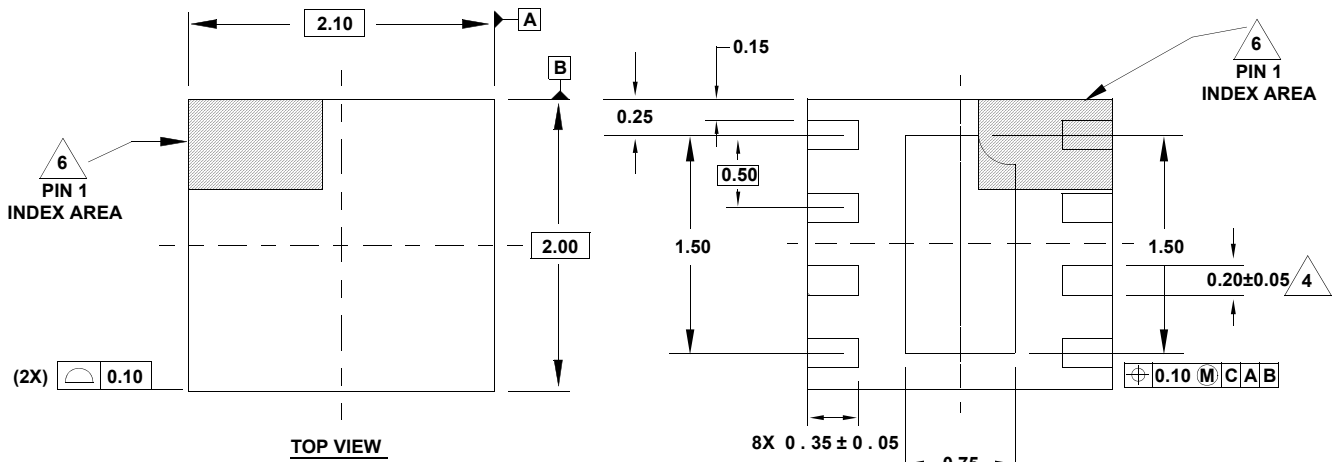
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Package Outline Drawing

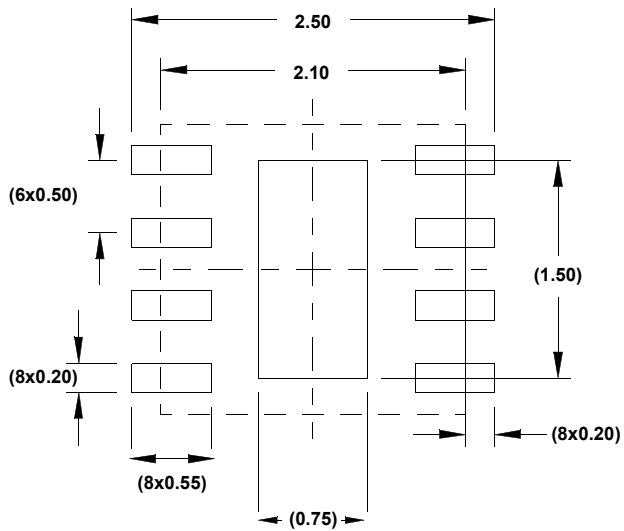
L8.2.1x2.0

8 LEAD OPTICAL DUAL FLAT NO-LEAD PLASTIC PACKAGE (ODFN)

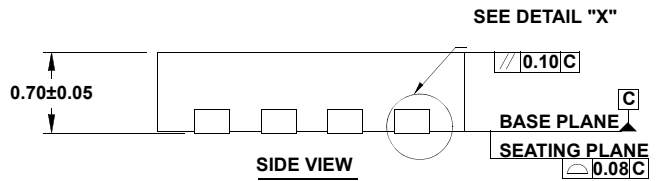
Rev 3, 1/11



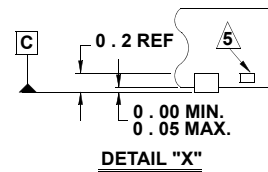
BOTTOM VIEW



TYPICAL RECOMMENDED LAND PATTERN



SIDE VIEW



DETAIL "X"

NOTES:

1. Dimensions are in millimeters.
Dimensions in () for Reference Only.
2. Dimensioning and tolerancing conform to ASME Y14.5m-1994.
3. Unless otherwise specified, tolerance : Decimal ± 0.05
4. Dimension applies to the metallized terminal and is measured between 0.25mm and 0.35mm from the terminal tip.
5. Tiebar shown (if present) is a non-functional feature.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.